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DEVELOPMENT OF TECHNOLOGY TRANSFER ECONOMIC GROWTH METRICS

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A. Introduction

The primary objective of this project is to determine the feasibility of producing technology transfer metrics that answer the question: Do NASA/MSFC technical assistance activities impact economic growth? The data for this project resides in a 7800-record database maintained by Tec-Masters, Incorporated. The technology assistance data results from survey responses from companies and individuals who have interacted with NASA via a Technology Transfer Agreement, or TTA.

The data are typically reported in three ways: economic impact, the number of products developed, and the number of jobs created or saved due to expansion, increased sales, or increased capital investment. Economic impact (EI) is calculated by the following method:

$$\text{EI (\$)} = \text{EI Due to Jobs} + \text{EI Due to Investment} + \text{EI Due to New Sales} + \text{Savings} \quad (1)$$

The number of products is simply summed, and the formula for calculating the number of jobs created or saved may be summarized as:

$$\text{Jobs} = \text{Jobs Due to Investment} + \max(\text{Jobs Saved or Created, Jobs Created by Sales}) \quad (2)$$

Criticisms of this metrics methodology (NAPA, 1997; Barnett and Thompson, 1996) focus on the use of jobs as part of the economic measure and the reporting of job creation in general. They suggest that data and measures that show evidence of wealth creation or growth are better measures of economic impact. They do, however, state that the creation of employment opportunities is an indicator of an increase in real national income.

There are several ways that wealth creation or growth may be defined:
- An increase in the wages of those impacted by tech transfer. This approach is also known as technology infusion and may be viewed as an element of productivity.
- An increase in the value of goods and services by customers outside the region, better known as exports (Sibert).
- An increase in the basic factors of production. This is characterized by increased investment in worker training to increase labor input, build more plants and equipment and improve technology to increase capital input, or discover more natural resources (Barron and Lynch, 1993).
- An increase in productivity. The best method of measuring productivity is debatable. At a minimum, it does require reporting of cost savings and new investment.
- An increase in the production of goods and services through capital formation. Capital stock includes factories, machinery, farms, offices, etc. In a general sense, it also includes less tangible products like education and scientific knowledge (Jones, 1982).

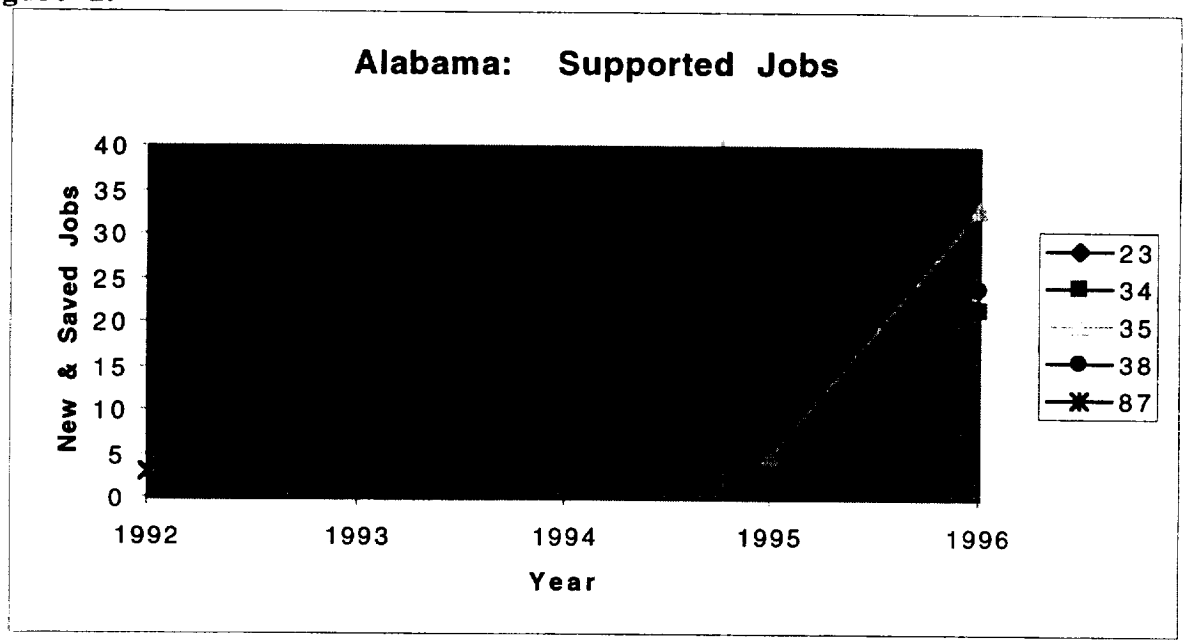
Since the database does not contain the information needed to address these definitions, the overall goal of this project is to analyze the technical assistance data for evidence of economic growth. Specific objectives are to study trends in the top SIC codes, to analyze job growth and compare to Department of Commerce values, and to analyze the effect of technology transfer efforts on wages.

B. Methodology

NASA/MSFC's TTA efforts have interacted with most of the industries as identified by 1987 SIC codes; the majority of which are in the manufacturing and engineering service industries. In examining the trends in jobs by SIC codes, the first step is to determine the top SIC codes. The top SIC codes were identified by total supported jobs–the sum of jobs created and saved. Figure 1

show these trends for the state of Alabama; other states are may be found in the Appendix. Figure 1 also indicates the problem with studying trends in SIC codes by state: limited data. Alabama significantly benefits from technical assistance, and the other states in the SE Alliance do not have enough job data to show continuous trends (positive, negative or otherwise). Note: The numbers reported in the figure are not cumulative but are the supported jobs realized that year.

Figure 1.



The top SIC codes, as identified by the number of supported jobs, for the SE region are shown in the first column of Table 1. As the table shows, while NASA has interacted with many industries, the majority of supported jobs are in the manufacturing industries. In attempting to determine the economic impact in these categories relative to Bureau of Economic Analysis values, a jobs-per-company approach was used. An example in support of this approach may be found in the apparel industry: the support of 361 jobs in this industry is a small perturbation when compared to the total employment in the SIC code: 393,000. However, comparing jobs/company in the key SIC codes supported by technical assistance to the equivalent national metrics may be of interest.

Table 1.

SIC Code	Description	Direct Primary Jobs	# of Companies	Jobs/Company
20	Food & Kindred Products	18.01	21	0.858
23	Apparel	361.06	123	2.935
25	Furniture & Fixtures	16.00	20	0.800
30	Rubber & Misc Plastics	14.31	71	0.202
34	Fabricated Metal Products	112.44	154	0.730
35	Machinery & Computer Equip.	79.21	143	0.554
36	Electrical Eqipment	13.62	66	0.206
37	Transporation Equipment	44.82	94	0.477
38	Instruments	34.86	83	0.420
51	Wholesale Trade	32.00	14	2.286
87	Engineering Services	24.59	133	0.185

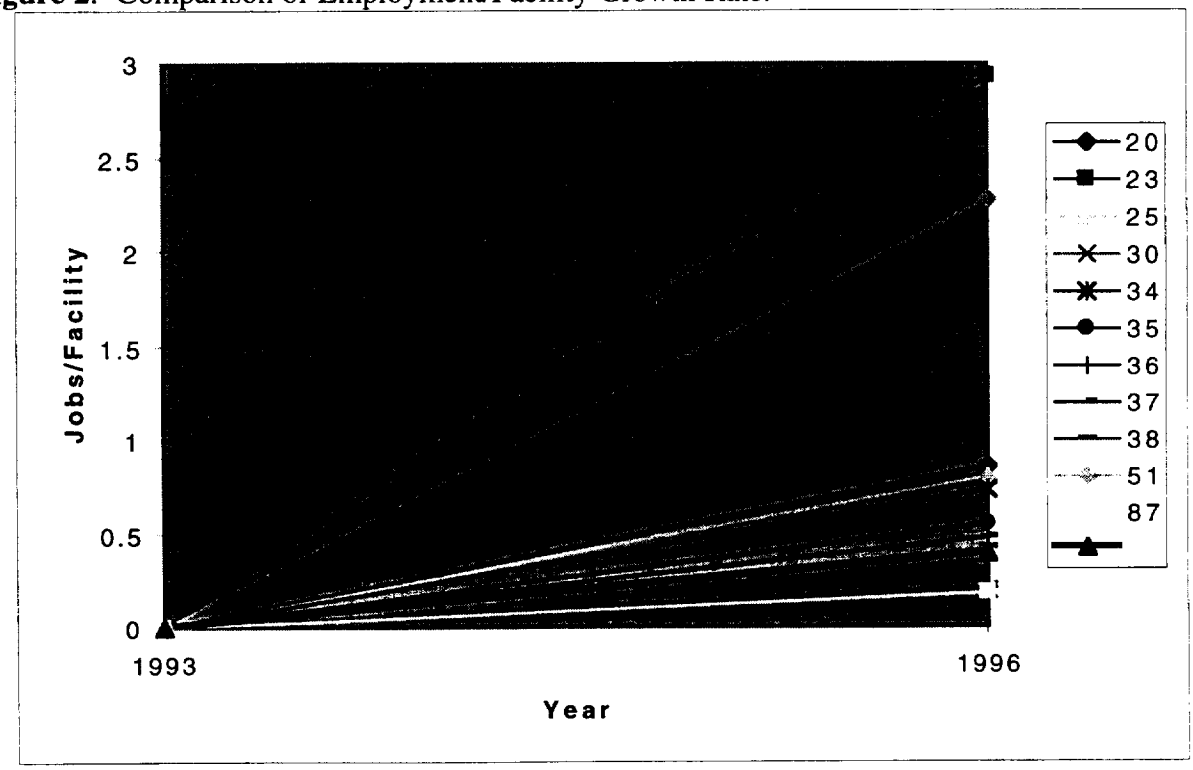
To obtain these metrics, the number of unique establishments that NASA worked with needs to be calculated. This is not a simple task since NASA may work with a company on several TTAs. In addition, the SIC codes for the companies who did not respond to the survey need to be determined. The entire metrics database contains 7879 records; 2224 of which represent the closed, MSFC, SE states (P1-P6 MSFC data). Over a third of the records (837) did not have SIC codes. After many days, only 61 remained unidentified, and the last columns of Table 1 were complete. The number of companies (unique and total) for all SICs may also be found in the Appendix. In the table, Direct Primary Jobs differ from supported jobs. Direct Primary Jobs represent the max(jobs saved or created, jobs created by sales). Jobs created from sales represent de-RIM'd values.

For comparison purposes, overall economic values for wages and employment by industry were obtained from the REIS CD ROM and Stat-USA. The number of establishments by industry from the Census bureau.

C. Results

Figure 2 compares the direct primary jobs per company that result from technical assistance to the employment per company for all non-farm proprietors. In the figure, the job growth rate for non-farm proprietors is the bold black line (with the triangle symbol). 'Non-farm' includes both government and private industry for both the employment and the proprietor numbers. Overall, the figure shows that for the SE region, job growth rates, on a per company basis, are larger.

Figure 2. Comparison of Employment/Facility Growth Rate.



This means that in 1996, on average, a proprietor employed an additional .39 of a person than it did 4 years prior. This figure may be viewed as an upper bound, because it includes all industries as well as government employment. Ideally, the job growth resulting from technology transfer should be compared to job growth per 2-digit SIC code. In Figure 3, the comparison is shown for

the apparel industry (SIC 23). The data for the other industries studied may be found in the Appendix.

Figure 3. Job growth rate for the apparel industry.

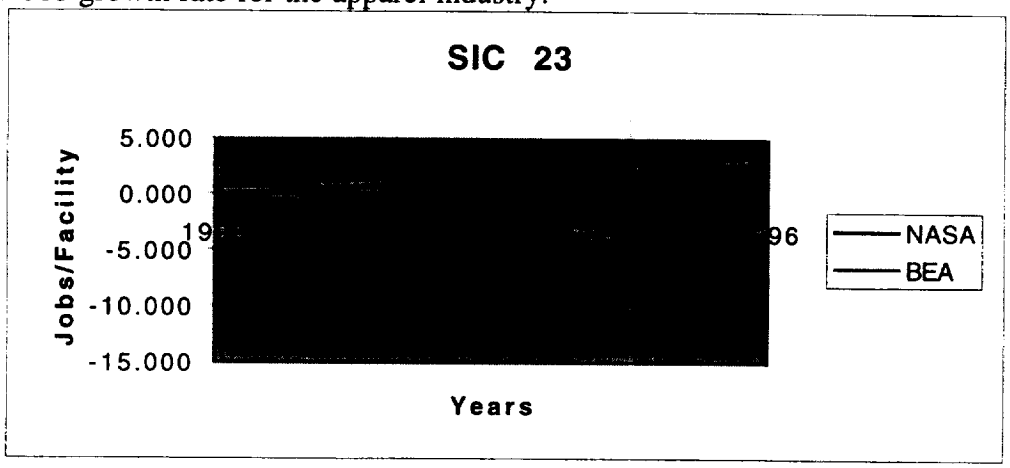
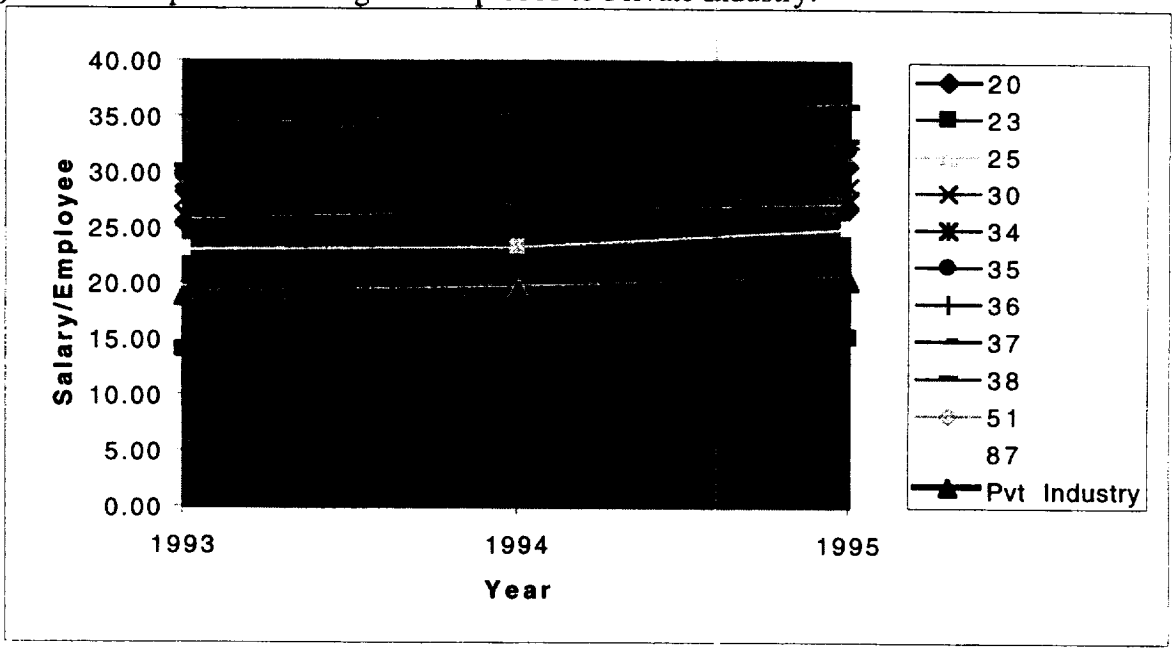


Figure 4 compares the per employee salary in the top NASA/MSFC SIC codes to that measure for private industry for the SE region. Except for apparel and furniture, the average salary is larger than that of private industry. In this figure, the bold comparison line differs from that of the previous figure in that it is private industry only and does not include government.

Figure 4. Comparison of Wages in Top SICs to Private Industry.



D. Conclusions

This goal of this project was to determine if the existing data could provide indications of increased wealth. This work demonstrates that there is evidence that companies that used NASA technology transfer have a higher job growth rate than the rest of the economy. It also shows that the jobs being supported are jobs in higher wage SIC does, and this indicates improvements in personal wealth. Finally, this work suggests that with correct data, the wealth issue may be addressed.

Future work in this area include expansion to other technology transfer interactions such as Space Act Agreements and expansion to regions beyond the SE Alliance. Other interesting work may involve the formulation of decision analysis models for determining candidate companies for licensing a technology by evaluating their capabilities.

E. References

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